

# Estimating Pedestrian Activities from Digital Footprints

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# Presentation Outline

## 1. Motivation:

What sensors to estimate demand?

## 2. Method:

Activity locations from signals and prior

## 3. Results:

How many students are going to class?

## 4. Conclusion and Future Works

# I. Motivation: What sensors to estimate demand?

# Demand estimation for pedestrian facilities

- Walking is a key in **multimodal transport systems**
- Urban growth puts **pressure** on urban infrastructure
- Need of **decision-aid models** for: congestion, design of new facilities, large events, travel guidance and security

# Data at the scale of pedestrian facilities

- Cameras?
- Data from the smartphones?
- Digital footprints from WiFi access points:
  - ▶ Available
  - ▶ Mode is mostly walking in these contexts
  - ▶ No additional costs required

# 2. Method:

## Activity locations from signals and prior

# Measurement model

- Input: measurement  $\hat{s} = (\hat{x}, \hat{t})$
- Output: list of activities  $a = (x, t^-, t^+)$

## Measurement likelihood

$$P(a_1, a_2, \dots, a_n | \hat{s}_1, \hat{s}_2, \dots, \hat{s}_m) = \frac{P(\hat{s}_1, \hat{s}_2, \dots, \hat{s}_m | a_1, a_2, \dots, a_n) \cdot P(a_1, a_2, \dots, a_n)}{\sum_{a \in A} P(a_1, a_2, \dots, a_n)}$$

Activity probability

Prior knowledge

# Measurement model

- Input: measurement  $\hat{s} = (\hat{x}, \hat{t})$
- Output: list of activities  $a = (x, t^-, t^+)$

$$\begin{aligned}
 P(a_1, a_n, \dots, a_n) &= P(\dots, x_{i-1}, t_{i-1}^-, t_{i-1}^+, x_i, t_i^-, t_i^+, \dots) \\
 &= \dots \cdot P(x_i | t_i^-, t_i^+) \cdot P(t_i^- | t_{i-1}^+, x_{i-1}, x_i) \cdot P(t_i^+ | x_i, t_i^-) \cdot \dots
 \end{aligned}$$

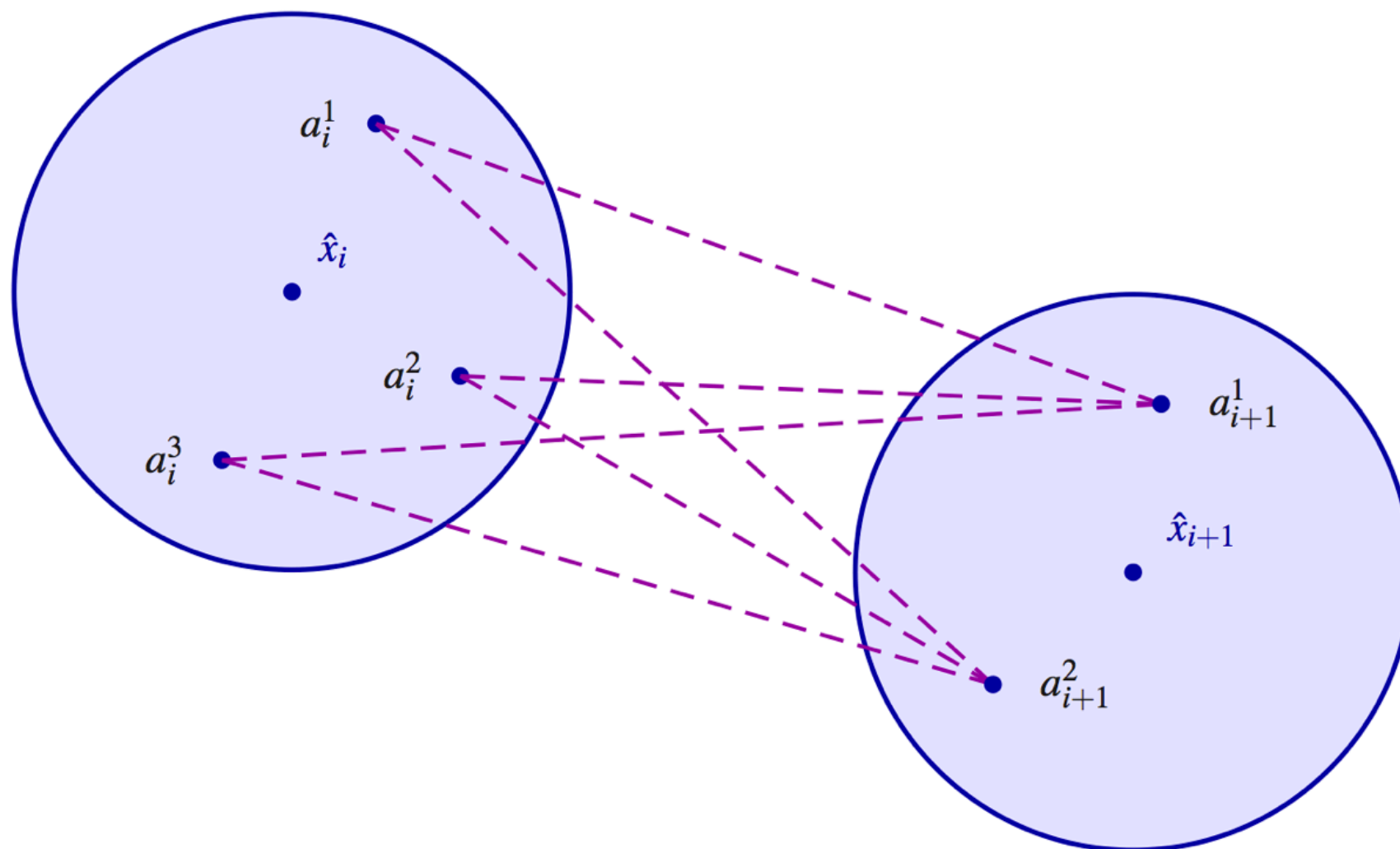
prior probability of visiting  
a specific place  
during a time window

activity model  
(time spent at activity)

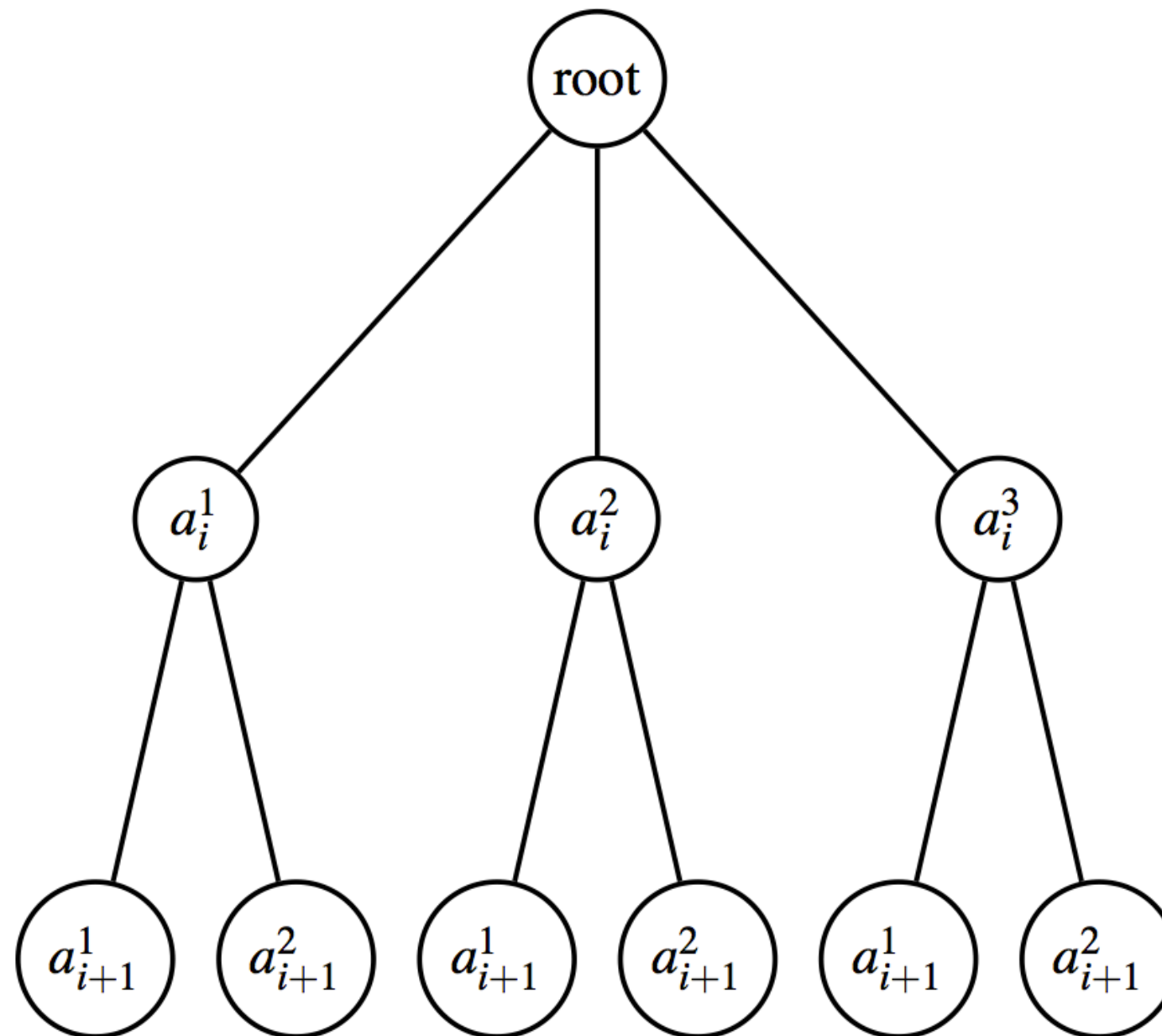
travel model



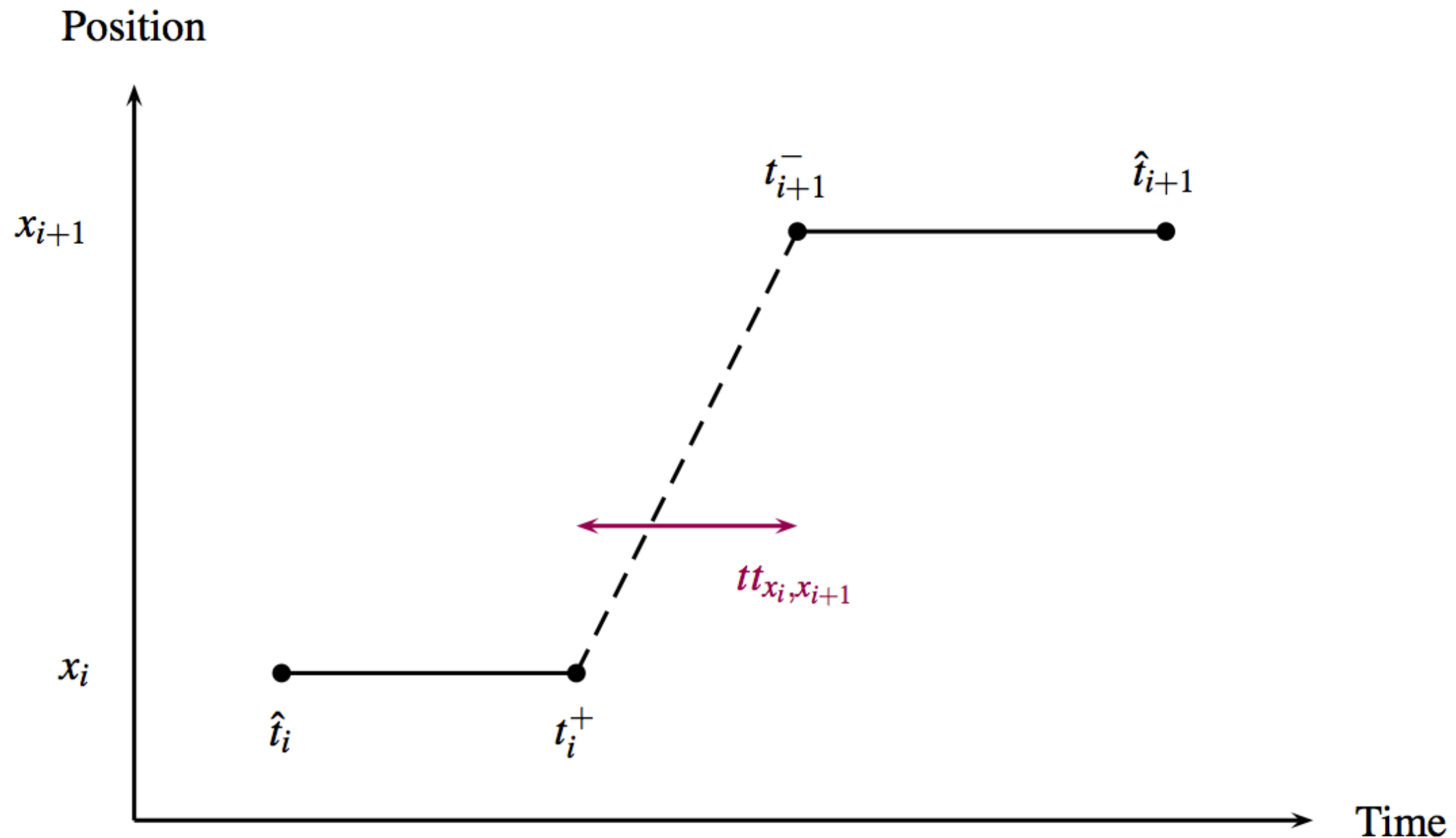
# Generation of lists of activities



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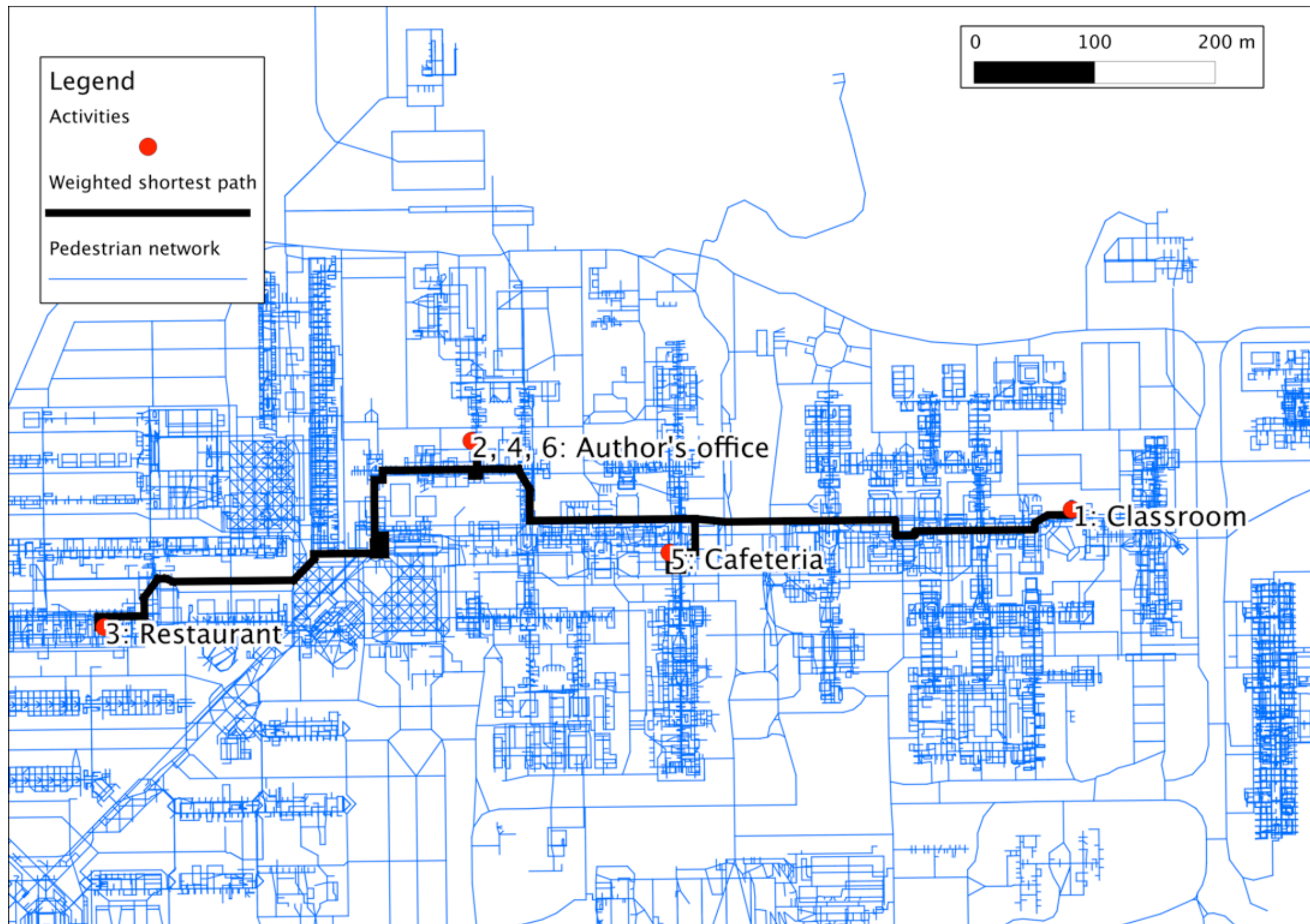


# Generation of lists of activities

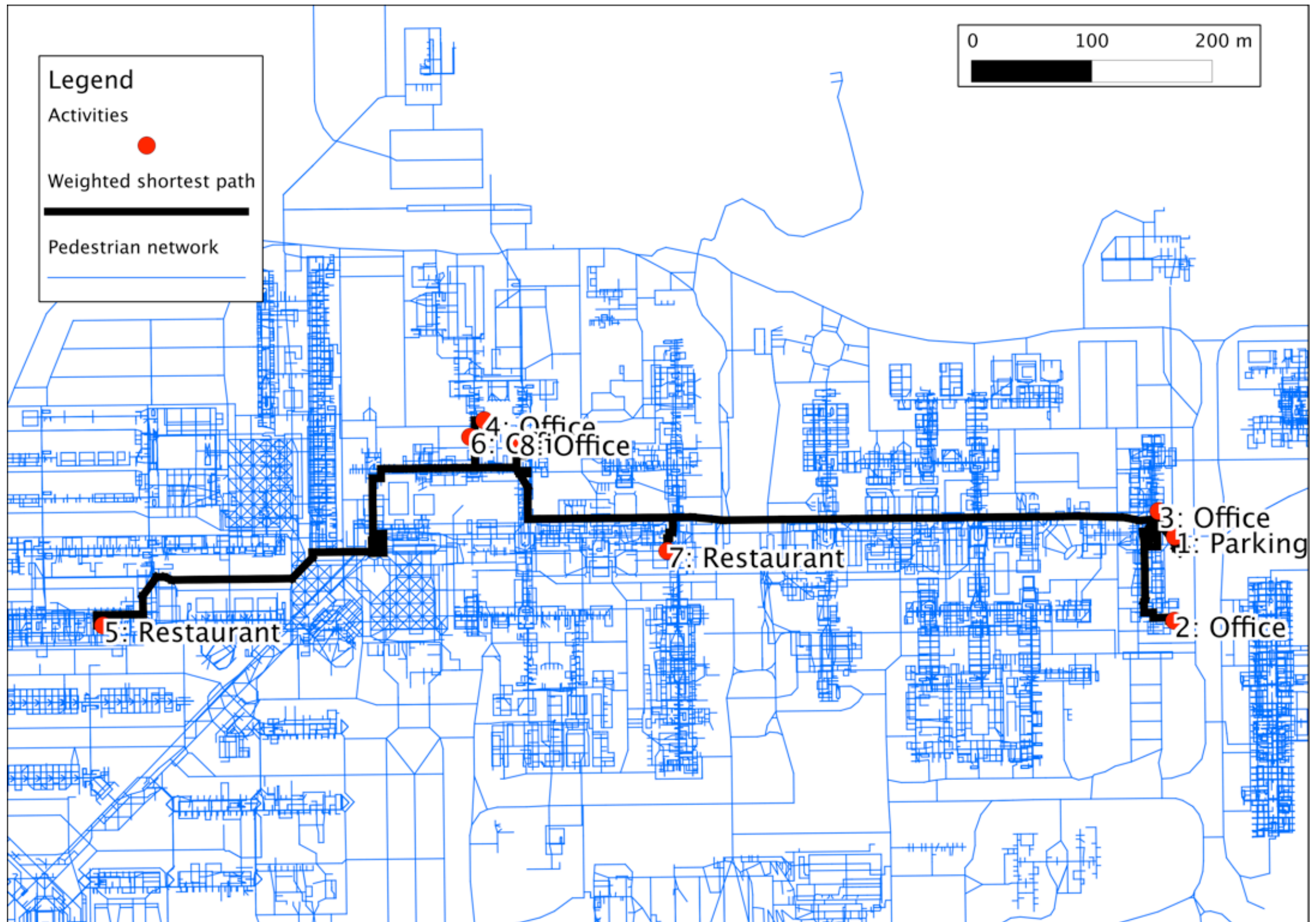


# 3. Results:

## How many students are going to class?







# Tracking a cohort of students

- 1 day, 12 students in Civil Engineering
- Stars are courses
- Colored circles are students

Video not available in PDF format

Please visit:

<http://www.youtube.com/watch?v=SEp-yNXLfUY>



# 4. Conclusion: Towards an activity-based model

# Conclusion: flexible, tunable and informative

- This methodology is:
  - ▶ Flexible: could be adapted for railway stations and other data sources
  - ▶ Tunable: prior information can be easily added
- Quite accurate but close locations are sometimes corresponding to different activities

# Future works: towards activity-based models

- Extend vehicle-based **activity-based models** to pedestrians
- using **latent classes** (e.g., students and employees) and **prior knowledge about** access to the area
- in order to synthesize a **full population**.

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